Chapter 2 Introduction to Community-Scale Assessment

Table of Contents

2.0 Introduction

The mission of the United States Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment – air, water, and land – upon which life depends.[1] Following this mission, the Agency has implemented a variety of laws and programs that require and encourage the safe use and management of toxic chemicals. Many of these programs focus on understanding the consequences of releasing chemicals to the air, land, and water and working to reduce those releases when they pose too great a risk. As described in the National Research Council's 1994 report, *Science and Judgment in Risk Assessment* (the "Blue Book"), risk assessment has frequently been adopted by Federal and state governments as a means for regulating hazardous substances.[2]

This chapter provides an introduction to the importance of assessment and mitigation of the variety of environmental risk factors that may affect communities. The discussion begins with toxic chemicals released to or created in the air (a ubiquitous problem across the United States) followed by a discussion of other common community environmental toxics concerns. The chapter concludes with a discussion of the importance of stakeholder involvement in community-scale assessment and risk mitigation efforts.

2.1 Air Pollution at the Local Level

The potential impacts of chemicals released to (or created in) the air depend on a number of factors, including the quantity of chemicals in the air, the location of the sources, how the chemicals move and transform in the environment, the length of time people or the environment is exposed, the toxic nature of the chemicals, susceptibility/sensitivity of the people exposed (e.g., due to an genetic susceptibility or a pre-existing medical condition), the ability of the exposed population to prepare for or recover from exposures, and other attributes of the exposed population. The human health effects of exposure to air pollutants can range from no response, responses that are relatively minor and reversible (such as mild eye irritation), responses that are more serious and debilitating (such as cancer) and, in some cases, fatal responses. Air pollution also can cause negative impacts on the environment, including distress and death in plants and animals, as well as damage to buildings and important cultural sites.

In the mid-20th century, Congress recognized the potential for air pollution to cause these kinds of problems and responded by enacting the Clean Air Act (CAA). Since that time, this Act, as amended, has provided the primary authority that EPA uses to develop programs for protecting people and the environment from the harmful effects of air pollution across the United States. For example, in the area of air toxics risk reduction:

- Strict control technology requirements on a number of categories of stationary sources (e.g., major industrial sources such as chemical plants, oil refineries, steel mills) have resulted in dramatic decreases in air toxics emissions over time. In addition, technological advances in motor vehicle and engine design, together with cleaner, higher-quality fuels, have reduced emissions so much that EPA expects the progress to continue, even as people drive more miles and use more power equipment every year.

Based on the data in the National Emissions Inventory (NEI),[a] estimates of nationwide air toxics emissions from these and other sources decreased by approximately 24 percent between baseline (1990-1993) and 1996. Thirty-three of these air toxics that pose the greatest threat to public health in urban areas have similarly decreased 31 percent. Although changes in how EPA compiled the national inventory over time may account for some differences, EPA and state regulations, as well as voluntary reductions by industry, have clearly achieved large reductions in overall toxic air pollutant emissions.

- Over the sixteen years from 1988 to 2003, total on- and off-site disposal or other releases of Toxics Release Inventory (TRI) chemicals decreased by 59 percent (by 1.87 billion pounds), including a 73 percent decrease in air emissions, looking at trends in the industries and chemicals that have been consistently reported since that time.

The 1990 Amendments to the CAA require that EPA significantly reduce emissions to the air of a particular set of chemicals that are known or suspected to cause serious health problems, such as cancer or birth defects. There are currently 187 **hazardous air pollutants (HAPs)**[b] that are regulated. This group of chemicals is also commonly referred to as the HAPs, **toxic air pollutants**, or simply **air toxics**. (The CAA also covers another important group of chemicals, known as **criteria air pollutants**; these various groups of air pollutants are discussed in more detail in Chapter 3.)

Many different types of sources can release air toxics. These sources include stationary facilities that individually release above threshold quantities of HAPs to the air (known as **major sources**); stationary facilities that individually release below threshold quantities of HAPs to the air (known as **area sources**); on-road and nonroad **mobile sources** (such as cars, trucks, and construction equipment) that release HAPs to the air; **indoor sources** of air toxics (such as paint, cleaning products, and second hand smoke); and **natural sources** of air toxics (such as fires, trees, soil, and volcanoes). Chapter 3 provides a detailed description of how EPA identifies and, in the case of anthropogenic (manmade) sources, regulates each of the various types of sources of air toxics.

Air toxics can also be released as a result of accidents, such as an explosion of a large storage vessel or the rupture of a tank car. Risk and hazard assessments of accidental releases are not discussed in this volume; in addition, the release and accumulation of gases under unusual circumstances such as an accidental release are not explicitly discussed. Resources on these other topics are available from EPA's Chemical Emergency Preparedness and Prevention Office (see http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/index.htm).

---

[a] The NEI is EPA's main inventory of air toxics emissions in the United States. It is updated every three years and contains information on stationary sources, mobile sources, and miscellaneous other sources such as certain forest fires. The NEI is discussed in detail in Chapter 4.

[b] Since the original Act (which listed 189 chemicals) two chemicals listed individually on the list of HAPs, caprolactam and methyl ethyl ketone, have been delisted, bringing the total number of listed air toxics to 187. One other chemical, ethylene glycol butyl ether (EGBE), was removed from the glycol ethers category (however, glycol ethers remains as a listed category). EPA has the authority to add and delete chemicals from the original list based on specified criteria [CAA Section 112(b)(3)].

2.1.1 Why Are There Special Concerns about Air Toxics at the "Community Scale?"

In a typical urban area (i.e., at the "community scale"), toxic air pollutants are of particular concern because people and sources of emissions are concentrated in the same geographic area. Since most people live in metropolitan areas,[c] this proximity leads to the potential for large numbers of people to be exposed to numerous air pollutants (some at potentially high concentrations). Within these communities, there may be additional exposure considerations of concern, including populations with special sensitivities (e.g., children and the elderly) or environmental justice communities (see Section 2.1.3).

Just How Big (or Small) is "Community Scale?"

There is no prescriptive answer to this question; however, community-scale analyses commonly range in size from a single neighborhood up to as large as a metropolitan area. The size of the "community" that is assessed will depend on the questions the partnership team wants to answer and the resources they have to perform the evaluation (e.g., a larger study area may lead to a higher cost). A discussion of how to define the scope of a multisource cumulative air toxics assessment is provided in Chapter 4.

As an example, consider a crowded city with its numerous busy streets and highways, autobody shops, dry cleaners, gas stations, and any number of other potential air toxics sources (e.g., large manufacturing plants), all located in and impacting a relatively small geographic area. It is easy to understand how this type of situation could lead to significant impacts that are, by their very nature, complex and variable (i.e., the number and types of sources can change from place to place).

While some of these urban chemical exposures tend to be fairly similar across the country (e.g., ambient air concentrations of benzene from petroleum use tend to be similar across the lower 48 states), studies also indicate that the concentrations of air toxics in many urban (and some nonurban) areas can vary significantly from one location to the next. In addition, many sources of urban emissions tend to be relatively small in size but large in number (e.g., gas stations or mobile sources), and they typically emit chemicals at ground level where people are more likely to be exposed to them.

Perception of Risk as a Driver for Action

Concerns about air toxics at the community level often begin with the *perception* among people in the area that they are sick because of local air quality. While such perceptions may lead to direct actions to reduce emissions from a particular source, more often the initial "action" that is taken is to examine whether the facts support the perception. For example, some level of risk assessment (such as the methodology described in this document) may be performed to evaluate current exposures and what they may indicate in terms of potential health threats. In some cases an epidemiological analysis may also be performed to evaluate actual cases of disease in the context of past exposures. Investigators will also look at what is already known (e.g., in the scientific literature) about the chemicals and types of sources in question and their potential to pose exposures of potential public health concern.

[c] According to the 2000 census (www.census.gov), approximately 226 million out of 281 million Americans live in metropolitan areas.

The concern about multiple air toxics emissions at the community level is heightened by the fairly localized nature of many air toxics impacts. For example, it is common for a ground level toxic chemical emission to be undetectable (through monitoring) within a few miles from the point of release due to dilution and/or degradation. An exposure evaluation for such releases would need to focus on the people who spend time in the immediate vicinity of the point of release (i.e., at the community scale) and probably not the people more than a few miles away.[d]

Considering the large number of people potentially at risk from air toxics exposures, Congress directed in the 1990 CAA amendments that elevated outdoor (also called **ambient**) concentrations of air toxics in large urban areas be substantially reduced. In response to this mandate, EPA developed an **Integrated Urban Air Toxics Strategy**. This Urban Strategy, which was published in the *Federal Register* on July 19, 1999,[3] has since become EPA's **National Air Toxics Strategy** (the Strategy) and is part of the overall national effort to reduce air toxics. The Strategy presents an approach for reducing these risks by looking at the cumulative risks posed by multiple pollutants from multiple sources (mobile, area, major and indoor air) in urban areas. However, since air toxics exposures vary (in terms of toxic air pollutants and sources) among urban areas across the country, EPA's activities to reduce risk on a national scale may not address potential risks on the more local level. Consequently, the Strategy includes local and community-based initiatives which we envision will involve partnerships between EPA and the State, local, and Tribal governments.

In other words, the need to recognize the combined impact of all the various types of sources in a given area is an important factor when working to achieve meaningful risk reductions in ambient concentrations at the local level. Equally important is the recognition that air toxics exposures can and do vary from place to place, requiring approaches that are flexible enough to meet the needs of individual communities.

The Strategy attempts to address all the significant stationary, mobile, and indoor sources necessary to achieve protection of public health and the environment. The specific goals of the Strategy are to:

- Attain a 75 percent reduction in incidence of cancer attributable to exposure to HAPs emitted by stationary sources;

- Attain a substantial reduction in public health risks posed by HAP emissions from area sources; and

- Address disproportionate impacts of air toxics hazards across urban areas.

---

[d] This is not to say that some chemicals are not long-lived (i.e., persistent) in the environment or do not travel long distances once released to the atmosphere (a number of the air toxics do have these properties). Some chemicals may even transform in the atmosphere to a more toxic chemical as they travel downwind from the point of release. Depending on the chemicals being emitted in (or upwind of) a given study area, a range of temporal and spatial exposure scenarios is possible. The partnership team designing the risk assessment must take these issues into account during the planning, scoping, and problem formulation phase of the analysis (see Chapter 4).

The Strategy identifies four main areas of action to help achieve these goals:

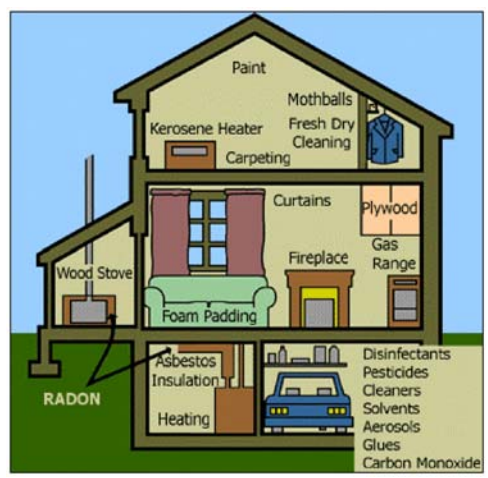
- **Develop regulations addressing sources of air toxics at the national and local levels**. Pursuant to this effort, the Agency will continue its work to develop rules that require reductions in air toxics emissions from stationary facilities (such as manufacturing plants, electric power plants, gas stations, and dry cleaners), as well as from cars, trucks, and other mobile sources and their fuels (Exhibit 2-1 provides an overview of progress in reducing air toxics emissions). EPA has historically developed and implemented many such standards over the years, and the Strategy indicates the need for additional standards to reduce risks in urban areas.

- **Initiate local and community-based projects to address specific multimedia pollutants (e.g., mercury) and *cumulative risks within urban areas***. The CAA requires EPA to "encourage and support area-wide strategies developed by the state or local air pollution control agencies" to address air toxics in urban areas. EPA is developing tools and is working with communities to assess and reduce risks at the community level. ATRA Volume 3 represents a key tool to help the Agency and its partners to help meet the specific Strategy goal of addressing cumulative risks within urban areas.

  The Strategy also recognizes the need to assess the risks from exposures to indoor air toxics and to develop non-regulatory, voluntary programs to address those risks. The Strategy also points out that air pollutants may move into other environmental media such as soil and water resulting in multimedia (i.e., more than just air) concerns. EPA is engaged in a number of activities that recognize the ability of several air toxics to deposit out of the air and bioaccumulate in biota consumed by humans and ecological receptors (e.g., deposition of mercury in watersheds, with subsequent uptake by fish – see Part III).

What About Sources of Indoor Air Toxics?

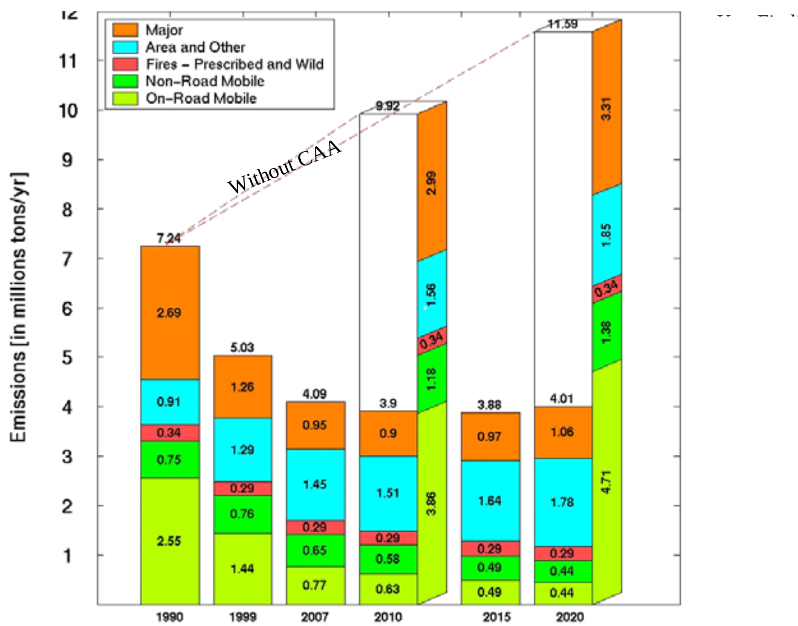
- Indoor air can become contaminated from numerous sources.
- Indoor air can have significantly higher concentrations of air toxics than outdoor air.
- EPA currently does not regulate indoor sources of air toxics.



(Although not shown in this figure, outdoor air is a source of indoor air toxics as well – via infiltration and ventilation. The importance of indoor air toxics sources on overall community exposure is discussed in Sections 3.2.4.1 and 4.3.)

Exhibit 2-1. Progress in Hazardous Air Pollutant Emissions

Total U.S. HAP Emissions* by Source Sector



This bar chart illustrates the decrease in HAP emissions to outdoor air from 1990 (baseline year) through 2020, assuming CAA controls (facing bars). The side bars indicate the estimated emissions that would occur in 2010 and 2020 without these controls.**

Note that indoor sources of air pollutants can be a significant contributor to an individual's overall air toxics exposure (information on ways to reduce exposure to indoor air pollutants is provided in Section 8.3.3). It should also be noted that, although reductions in emissions can result in decreased health risks, there is a distinction between emissions (i.e., the amount of chemical release to indoor or outdoor air) and the exposures that may result (i.e., the concentration of chemical in the air that people actually contact), with measures of exposure, rather than emissions, being preferred for assessing risk (see Exhibit 5-2).

*Except mercury.
**After 2010, stationary source emissions are based only on economic growth. They do not account for reductions from ongoing toxics programs such as the urban air toxics program, residual risk standards, and area source program, which are expected to further reduce toxics. In addition, mobile source reductions are based on programs currently in place. Programs currently under development will result in even further reductions.

Source: Strum, M., Pope, A., Thurman, J., Ensley, D., Palma, T., Mason, R., Cook, R., Shedd, S. 2005. *Projection of Hazardous Air Pollutant Emissions to Future Years*, Presented at the International Emission Inventory Conference: Transforming Emission Inventories - Meeting Future Challenges Today, Las Vegas, NV, April 14, 2005 (http://www.epa.gov/ttn/chief/conference/ei14/session10/strum.pdf).

- **Conduct air toxics assessments to identify areas of concern, prioritize efforts to reduce risks, and track progress**. The Strategy identifies a variety of national-level assessment activities that will help EPA identify urban areas of particular concern, characterize the risks that air toxics pose, and track the progress toward meeting overall air toxics program goals. EPA is implementing the National Air Toxics Assessment (NATA) to address this goal. NATA includes:

  – Expanding air toxics monitoring (i.e., the establishment of National Air Toxics Trend Stations, or NATTS, implemented to characterize air toxics trends on a national basis);[e]
  – Improving and periodically updating emissions inventories;[f]
  – Assessing national- and local-scale air quality by using multimedia and exposure modeling;
  – Continuing to research the exposures to, and health effects of, toxic chemicals in ambient and indoor air; and
  – Using and improving exposure and assessment tools.

  These activities will help EPA and other stakeholders[g] better understand air toxics risks as well as risk reductions associated with emissions control standards and other initiatives aimed at reducing emissions. (For additional information on the National Air Toxics Strategy see http://www.epa.gov/ttn/atw/urban/urbanpg.html.)

  A particularly high-profile aspect of NATA has been the national-scale assessment of 1996 and 1999 emissions that produced predictions of county-level estimates of air toxics concentrations and calculated risks for a subset of HAPs. This analysis indicates that risks posed by air toxics are still relatively high and widespread across the United States (see Exhibit 2-2).

- **Perform education and outreach**. Given the scientific complexity inherent in air toxics issues, EPA recognizes that the success of the overall air toxics program depends on the public's understanding of the nature of air toxics risks and the activities that can help reduce those risks. To further this understanding, EPA will support education and outreach efforts at the national level and through its state, local, and tribal (SLT) partners. This resource document, for example, is an outgrowth of this educational/outreach effort.

---

[e] Information on monitoring and the use of monitoring data for risk assessments can be found in ATRA Volume 1, Chapter 10.

[f] The Emissions Inventory Improvement Program (EIIP) was established to improve the quality of emissions information and to further the development of systems for collecting, calculating, and reporting emissions data (see http://www.epa.gov/ttn/chief/eiip/index.html). Additionally, the North American Research Strategy for Tropospheric Ozone (NARSTO) conducted an assessment on the status of North American emission inventories and suggested areas for improvement in future emissions inventories. More information about the NARSTO assessment is available at http://narsto.org/.

[g] This resource document uses the term "stakeholder" broadly to include all parties with a potential interest in a given air toxics risk assessment, including regulators, the regulated community, community partners, and individual members of the public. The "partnership team" is the group of people who come together as a group to perform the overall work of the assessment.

Exhibit 2-2. 1999 National Air Toxics Assessment Risk Characterization

In February 2006, EPA released the results of its national-scale assessment of 1999 air toxics emissions. The purpose of the national-scale assessment is to identify and prioritize air toxics, emission source types and locations which are of greatest potential concern in terms of contributing to population risk. The national-scale assessment includes 178 air pollutants [a subset of 177 air toxics on the Clean Air Act's list of 187 air toxics plus diesel particulate matter (diesel PM)]. The assessment includes four steps that focus on the year 1999:

- Compiling a national emissions inventory of air toxics emissions from outdoor sources;
- Estimating ambient concentrations of air toxics across the United States;
- Estimating population exposures across the United States; and
- Characterizing potential public health risk due to inhalation of air toxics including both cancer and noncancer effects.

This analysis found that more than 270 million people live in census tracts where the combined upper-bound lifetime cancer risk from these compounds exceeded 10 in one million risk and more than 190 million people live in census tracts where risk greater than 10 in one million resulted from known human carcinogens (Class A) alone. Some of the chemicals involved in these risks include benzene, arsenic, benzidine, 1,3-butadiene, chromium (VI), coke oven emissions, carbon tetrachloride, hydrazine, naphthalene, perchloroethylene, and polycyclic organic matter (POM).

Regarding noncancer hazard, EPA found that for two of the common health endpoints associated with air toxics (respiratory and neurological effects), the corresponding "hazard index" (i.e., the sum of the hazard quotients of the air toxics compounds that affect the respiratory or nervous system), are as follows: The respiratory hazard index, which was dominated by a single substance, acrolein, exceeded a value of 1.0 for nearly the entire U.S. population, and exceeded 10 for more than 48 million people. The neurological hazard index was similarly dominated by manganese compounds, with minor contributions by cyanide compounds, ethylene oxide, and mercury compounds. The neurological hazard index exceeded 1.0 for fewer than 800,000 people in the U.S.

The results provide answers to questions about emissions, ambient air concentrations, exposures and risks across broad geographic areas (such as counties, states and the nation) at a moment in time. As such, they help EPA identify specific air toxics compounds and specific source sectors such as stationary sources or mobile sources, which generally produce the highest exposures and risks in the country. However, they also are based on assumptions and methods that limit the range of questions that can be answered reliably. They cannot be used to identify exposures and risks for specific individuals and EPA recommends that the census tract data/maps be used to determine geographic patterns of risks within counties rather than to pinpoint specific risk values for each census tract. They also do not account for the reductions in emissions that have occurred since 1999 or those that will happen in the future due to regulations for stationary or mobile sources. These limitations, or caveats, must always be kept in mind when interpreting the results, and the results should be used only to address questions for which the assessment methods are suited. See additional limitations at http://www.epa.gov/ttn/atw/nata/natsalim2.html. For more information about NATA, see http://www.epa.gov/ttn/atw/natamain/.

As emphasized in the National Air Toxics Strategy, because the mix of sources and pollutants in specific community-scale geographic areas can be quite variable, one element of an effective approach for reducing any remaining unacceptable risks is to understand the cumulative impacts at the local level posed by the simultaneous impact of multiple pollutants released by multiple sources, target the problem sources and chemicals, and tailor risk reduction strategies to the local circumstances in those areas.

To encourage this type of air toxics risk reduction approach at the community level, EPA Headquarters and Regional Offices are working collaboratively with SLT and community partners to develop guidance, provide education/information exchanges, identify and assess pollution prevention and control options, and promote voluntary measures and innovative solutions to assess and address community air toxics problems.

In many cases these risks may be more appropriately and more effectively addressed at the SLT level, rather than at the federal level. Specifically, SLT air agencies may wish to address issues that are of concern on a state-wide, area-wide, community-wide, or individual neighborhood basis, and for areas in the immediate vicinities of specific air toxics sources. Some SLT governments are already addressing some of these issues; others are just beginning to develop their own programs.

2.1.2 Using a Risk-Based Approach for Addressing Community-Scale Air Toxics Issues

While there are several methodologies to assess potential health impacts of multiple sources of air toxics on populations at the local level, the risk-based approach is perhaps one of the most effective.

The general methodology described here, called **risk assessment**, is the process for evaluating:

- The sources of air toxics released to the environment;
- How the released chemicals move and change in the environment;
- Who may be exposed to the chemicals and at what levels;
- How exposures may occur;
- The toxic effects of the chemicals in question and how potent they are; and
- How likely it is that the potentially exposed people will experience harm because of the exposures.

In addition to impacts on humans, air toxics released to the atmosphere may also impact local ecosystems including adverse effects on animal and plant populations or on aspects of ecosystems on which they depend.

Strengths and Weaknesses of Risk Assessment

Before initiating a risk assessment as a way of addressing community-scale air toxics issues, analysts and stakeholders should be aware of some of the strengths and weaknesses of risk assessment. Some examples of each include:

Strengths

- Provides a systematic, tiered approach to problem solving
- Emphasizes data collection to address uncertainties
- Extensive guidance developed by EPA regarding risk assessment methodologies
- Provides a consistent basis for assessing the need for action and comparing impacts of a range of approaches/decisions

Weaknesses

- Traditionally incorporates conservative assumptions to fill data gaps, leading to potentially overstated estimates of risk
- Conclusions dependent on the quality of the underlying data

For more information on the pros and cons of using a risk-based approach to the assessment of air toxics, analysts may want to review *Science and Judgment in Risk Assessment* (see reference 2).

This kind of information can be extremely helpful to decision makers as they try to balance the competing concerns of protecting public health, fostering economic development, and evaluating issues of fairness and equity, among others. Specifically, risk assessment can provide:

- A predictive estimate of the potential health risks posed by air toxics, which may help determine the need for action;
- A basis for determining the levels of chemicals that can be released to the air without posing unacceptable risks to public health and the environment;
- A basis for comparing potential health impacts of various pollution reduction alternatives;
- A consistent process for evaluating and documenting threats to public health and the environment from toxic air pollution; and
- A basis for comparing risks from various exposure scenarios (e.g., the risk from breathing contaminated air compared to the risk from eating contaminated food).

Performing an air toxics risk assessment is often challenging. Risk assessments can be resource and time-intensive, depending on the specific questions being asked and the level of detail needed for informed decision making. Risk assessments usually require input from a number of scientists and engineers with a variety of skills (e.g., chemistry, toxicology, statistics, modeling, meteorology, monitoring). Decision makers may also need to acquire new skills in order to understand and use the risk assessment results. Finally, although they are based on science, risk assessments often rely on the best judgment of the analysts in the face of various uncertainties.

The general framework for performing and using the risk assessment approach to evaluate the simultaneous impact of multiple sources of air toxics on a local community is the focus of Parts II and III of this volume.

A multisource cumulative air toxics assessment at the community scale as a tool for reducing local risks will generally involve the following steps (and is discussed in detail in the next chapter):

- Evaluate the cumulative inhalation risk from air toxics sources in a defined geographic area;
- Evaluate whether the cumulative inhalation risk is acceptably low;
- If cumulative risk is not acceptably low, use the risk assessment results to identify the chemicals and sources that are causing the majority of the risk (i.e., the risk "drivers"); and
- Select risk reduction options (preferably for the sources and chemicals posing most of the risk – the risk drivers) that will bring the overall risk down to an acceptably low level.

Performing the analysis in this way can lead to more meaningful risk reduction in a community than simply focusing on one or a few sources because of a *perceived* threat. Note, however, that:

- Some communities may not have the desire or the resources to perform a comprehensive risk assessment approach and may opt for a simpler screening-level approach. [Section 3.5.1 discusses EPA's *Community Air Screening How To Manual* which provides information for communities that want to perform a screening-level assessment instead of (or as a prelude to) one of the other risk assessment approaches described in this resource document.]
- There are a variety of actions that any community can begin at any time that will provide meaningful risk reduction with little to no up-front analysis. For example, retrofitting older diesel school buses with newer pollution control devices, anti-idling options, and restrictions on secondhand smoke will all lead to significantly reduced risk for people in the community. Chapter 8 of this resource document discusses risk mitigation approaches for both outdoor and indoor air.

The Framework for Cumulative Risk Assessment

In response to the increasing focus on the combined risk posed to people from multiple environmental risk factors across all media (air, land, water, and contaminated food), EPA has developed a *Framework for Cumulative Risk Assessment* as the first step in the long-term effort to develop cumulative risk assessment guidance.

The Framework defines cumulative risk assessment as *an analysis, characterization, and possible quantification of the combined risks to human health or the environment from multiple agents or stressors*. The community-scale approach to air toxics assessment and risk reduction, as described in this resource document, is an outgrowth of the *Framework*.

The Framework and associated materials can be accessed at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54944.

Air Toxics Community Assessment and Risk Reduction Projects Database

An important component of EPA's efforts to reduce unacceptable risks from air toxics is to work with SLT organizations to understand the risks at the local level, target the problem areas, and tailor reduction strategies to the circumstances in those areas. EPA has developed a database of completed and ongoing community level air toxics assessments across the country to aid in this effort. By sharing information about local efforts to measure, understand, and address air toxics emissions, this database will help ensure that communities designing and implementing their own assessments will be able to build upon past efforts and lessons learned. The following information on each assessment is provided in the database:

- Project Title
- Status of Project (complete or ongoing)
- Study Dates
- Study Summary
- General Information
- Assessment and Analysis Methods
- Risk Assessment Project Design
- Findings
- Outcomes
- Public Involvement
- Document Downloads

The database can be accessed at:
http://yosemite.epa.gov/oar/CommunityAssessment.nsf/Welcome?OpenForm.

- Even when there is a high degree of certainty about the chemicals and/or sources that drive a community's cumulative air toxics risk, there may be practical or legal reasons why the partnership team may choose to focus their risk reduction efforts elsewhere. For example, the technology may not currently exist to reduce the emissions from an emission source, and the community, acting as the risk manager, may be willing to live with a somewhat higher risk rather than close the facility and lose a crucial source of jobs or close a thoroughfare and lose the business along a transportation route. (In this instance, the citizens, acting as "risk managers," have balanced the need for jobs with the level of additional risk in deciding how to respond to the results of the risk analysis. A discussion of the principles of risk management is presented in ATRA Volume 1, Chapter 27, and Chapter 8 of this Volume.)

2.1.3 Community-Scale Air Toxics Assessment and Environmental Justice Issues

EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, or commercial operations or policies. Meaningful involvement means that: (1) people have an opportunity to participate in decisions about activities that may affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision; (3) their concerns will be considered in the decision making process; and (4) the decision makers seek out and facilitate the involvement of those potentially affected."

A goal of environmental justice is to eliminate disproportionate risks or impacts across all groups, including low-income and/or minority populations. In 1999, the Institute of Medicine stated that "many communities contain potential sources of environmental risks (e.g., industrial facilities, waste treatment sites, or waste disposal sites). These can affect all racial, ethnic, and socioeconomic groups, but there is substantial evidence that minority and low-income groups face higher levels of exposure in terms of both frequency and magnitude."(4)

An overview of the role of environmental justice in environmental decision-making and the importance of multisource cumulative assessment and tools such as RAIMI in evaluating minority and/or low-income communities is provided here. More detailed information about environmental justice and it's role in EPA decision making can be found on EPA's Environmental Justice web page at http://www.epa.gov/compliance/environmentaljustice/index.html.

2.1.3.1 History of Environmental Justice at the Federal Level

The environmental justice movement was started by people, primarily people of color, who needed to address the inequity of environmental protection services in their communities. Grounded in the struggles of the 1960's civil rights movement, these citizens from every facet of life, emerged to elucidate the environmental inequities facing millions of people. These communities rose to articulate and sound the alarm about the public health threats which posed an immediate danger to the lives of their families, their communities and themselves.

In response to public concern, EPA established the Office of Environmental Justice in 1992. Within this office, a new organizational infrastructure was implemented to facilitate the incorporation of environmental justice into EPA's programs and policies. This included the creation of an Environmental Justice Executive Steering Committee, which provides leadership ensuring that environmental justice is incorporated into agency programs, as well as regional and program office environmental justice coordinators.

The National Environmental Justice Advisory Council (NEJAC) was created in 1993 to provide independent advice and recommendations to the Administrator of EPA on areas related to environmental justice. The NEJAC meets once a year to address the

> The National Environmental Justice Advisory Council (NEJAC) is a federal advisory committee established to provide independent advice, consultation, and recommendations to the EPA Administrator on matters related to environmental justice. Several NEJAC reports provide guidance on involving historically disenfranchised groups in community efforts including:
>
> - Environmental Justice in the Permitting Process
> - Environmental Justice and Community-Based Health Model Discussion
> - NEJAC Report on Integration of Environmental Justice in Federal Programs
> - Fish Consumption and Environmental Justice
> - Advancing Environmental Justice Through Pollution Prevention
> - Cumulative Risks/Impacts and Environmental Justice
>
> Information about NEJAC, its function, meetings, and products, is available at http://www.epa.gov/compliance/environmentaljustice/nejac/

concerns of community members, nonprofit and environmental organizations, tribes, academia, industry, and state and local government groups. The NEJAC Executive Council has 26 members drawn from important environmental justice constituencies and an additional seven subcommittees, including Air and Water, Enforcement, Health and Research, Indigenous Peoples, International, Puerto Rico, and Waste and Facility Siting.

Former President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* on February 11, 1994. This Order directs attention to the environmental and human health disparities typical of minority and/or low-income communities. The Federal Interagency Working Group on Environmental Justice (IWG), established pursuant to this Order, consists of eleven federal agencies and several White House offices. Presently, the IWG has three task forces: Health Disparities, Native American, and Revitalization Demonstration Projects. These task forces address a variety issues related to some aspect of environmental justice, ranging from preservation of sacred tribal sites to community rehabilitation to assessment and examination of discrepancies in health.

Case Study

A Class I toxic waste dump was built in the late 1970s outside of Kettleman City, a small, predominately Latino agricultural community. When news of its proposed expansion reached the town, residents were shocked to learn that the dump just three miles from their homes had violated state environmental regulations on multiple occasions, yet was preparing to construct new facilities for incineration of additional waste. Residents and community leaders formed a citizen's group, El Pueblo para el Aire y Agua Limpio (Citizens for Clean Air and Water), that took legal action against the corporation operating the facility and was successful in preventing further expansion of the incinerator. Instrumental in strengthening the resolve of the community was Kettleman City residents' discovery of the Cerrell Report (1984). The report suggested that companies building waste incinerators would find the least resistance in small, rural, poor, uneducated, blue-collar communities. This was a suspiciously accurate description of Kettleman City, as well as the two other communities home to Class I toxic waste dumps in California.

Source: Cole, Luke W. and Sheila R. Foster. *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. NYU Press: New York, 2001.

2.1.3.2 Environmental Justice and Multisource Cumulative Assessment

One of the main goals of environmental justice is to ensure that no group, including racial and socioeconomic populations, is disproportionately burdened with negative environmental and health impacts associated with pollution. Multisource cumulative assessment attempts to characterize the multiple sources and chemicals, exposures, and pathways of pollution affecting human and environmental health within a defined geographical area. Ideally, these assessments should also attempt to incorporate the many risks or population-specific susceptibilities that are particular to a community, including those that are unique to or more prevalent in minority and/or low-income communities. For example, community health is affected by stresses (e.g., economic, societal, cultural) other than exposure to pollutants.

The tools and approaches available for multisource assessment that are described in this resource document, especially the Regional Air Impact Modeling Initiative (RAIMI) as well as the Human Exposure Model (HEM), provide an objective method for assessing risk both for the entire community and for specific segments of a community, including minority and/or low-income neighborhoods. Multisource cumulative assessments can be used to assess the relative exposure and risk faced by each neighborhood. **However, these tools and approaches do not provide a basis for determining whether or not any group, including minority and/or low-income populations, is experiencing a *disproportionate burden* of risk. The tools for determining disproportionate risk or impacts are being developed.** Moreover, that decision should include the input of each community, based on their own standards and values.

2.2 Environmental Concerns Other Than Air Toxics Emissions to Air

During its first 34 years, EPA, along with its state, local, and tribal government partners, has achieved substantial environmental progress using regulatory standards and voluntary programs to protect human health and the environment from a wide array of environmental threats (see Exhibit 2-3). However, even with the great strides in environmental management, a number of important issues remain. For example:

- Fish advisories that limit or restrict consumption are widespread across the United States, and many water bodies are under some form of fish consumption advisory (http://www.epa.gov/ost/fish/).

- Many homes built before 1978 contain lead-based paint, a potent childhood neurotoxin and some urban drinking water systems may have elevated lead concentrations (http://www.epa.gov/lead/).

- Many households purchase and use a variety of pesticides, including: cockroach sprays and baits; insect repellents for personal use; rat and other rodent poisons; flea and tick sprays, powders, and pet collars; kitchen, laundry, and bath disinfectants and sanitizers; products that kill mold and mildew; certain lawn and garden products, such as weed killers; and certain swimming pool chemicals. All of these products can be potentially harmful when improperly used or disposed (http://www.epa.gov/pesticides/).

While air toxics are often of central interest to community stakeholders, their concerns will often expand to include these additional types of issues. Some of these "non-air" concerns may be commonly occurring issues throughout many communities across the United States, while others may be particular to a given region or even unique to a specific community. For example, protection of public drinking water supplies may be a common interest in communities across the U.S., while concerns about an abandoned hazardous waste site will be of concern primarily to the neighboring community.

An understanding of the overall impact of all environmental toxicants on a community would require an evaluation of risk across this multitude of environmental risk factors (in addition to air toxics). The current level of scientific understanding as well as the tools to do such analyses are still in the development stage. There are, however, some assessment techniques and actions that can be performed (e.g., comparative risk analysis, or CRA) to help communities identify their more pressing environmental risk factors and select mitigation projects that can result in meaningful risk reduction. A discussion of the CRA process and various risk mitigation approaches is provided in Part IV.

Additional Environmental Justice Resources and References

Environmental Justice Alternative Dispute Resolution Training (http://www.epa.gov/compliance/resources/publications/ej/)

EPA Environmental Justice Program (http://www.epa.gov/compliance/environmentaljustice/)

National Environmental Justice Advisory Council (http://www.epa.gov/compliance/environmentaljustice/nejac/index.html)

Ensuring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts - Executive Summary (http://www.epa.gov/Compliance/resources/publications/ej/nejacmtg/nejac-cum-risk-reort-exec-summary.pdf)

Environmental Justice Training (http://www.epa.gov/compliance/training/index.html)

Environmental Law Institute Reports (http://www.elistore.org/reports.asp)

Communities and Environmental Laws Video (EPA, Office of Environmental Justice)

Advancing Environmental Justice through Pollution Prevention (http://www.epa.gov/compliance/resources/publications/ej/)

Office of Solid Waste, Environmental Justice web site (http://www.epa.gov/epaoswer/osw/ej/)

Social Aspects of Siting Hazardous Waste Facilities (http://www.epa.gov/epaoswer/hazwaste/tsds/site/k00005.pdf)

EPA Office of Air and Radiation TribalAIR website (http://www.epa.gov/air/tribal)

Science Policy, Environmental Justice Conference (Boston, MA 2004) "Science to Action: Community-based Participatory Research and Cumulative Risk Analysis as Tools to Advance Environmental Justice in Urban, Suburban, and Rural Communities." (http://epa.gov/osp/regions/envjust.htm)

The Environmental Justice Resource Center at Clark Atlanta University (http://www.ejrc.cau.edu)
Toward Environmental Justice: Research, Education, and Health Policy Needs (1999) (http://books.nap.edu/books/0309064074/html/index.html)

Lester, James P., David W. Allen, and Kelly M. Hill. *Environmental Injustice in the United States: Myths and Realities.* Boulder: Westview Press, 2001.

Exhibit 2-3. Example Advances in Environmental Quality

Water Quality. Over the past 30 years, EPA and its federal, state, and tribal partners have made significant progress in protecting and restoring the nation's waters. Today, more Americans have safe, reliable, and affordable drinking water, and people can fish, swim, and travel safely in rivers that were once polluted. For example, EPA has established and is working to implement health-based drinking water standards for more than 90 contaminants. To help drinking water systems implement the standards EPA, states, tribes, and key stakeholders work together to provide water systems with extensive technical assistance and training. Over the past decade, the Agency and its partners have made significant progress in providing the public with drinking water that meets health-based standards.

Land Preservation and Restoration. EPA's waste management and emergency response programs work with state, tribal, and local governments to implement and oversee 15 separate statutory authorities. Many stakeholders—including non-governmental organizations, industry associations, and Federal Advisory Committee Act groups—assist in these efforts. Four themes characterize this program: Revitalization (restoring contaminated land to economically viable use); the One Cleanup Program (a program to look across all cleanup programs to increase consistency and enhance effectiveness); Recycling, Waste Minimization, and Energy Recovery; and Homeland Security. As an example of success in this area, by the end of fiscal year 2004 the Superfund program completed construction at 926 sites and 458 construction projects were continuing at 345 sites (excluding federal facilities) with two-thirds of these projects (309) led by Potentially Responsible Parties. As a result of Superfund's cleanups, 490 NPL sites now have land ready for reuse, and 300 of these are in use.

Chemicals and Pesticides. EPA is committed to preventing risks from new chemicals and pesticides entering the environment, as well as to addressing legacy issues from old bad actors. The Agency reviews new chemicals and pesticides before they are put on the market, reassesses older chemicals and pesticides already in use, and takes appropriate action should they pose unacceptable risks. Working with industry, EPA has now screened over 22 percent of the more than 76,000 commercial and/or industrial chemicals in the U.S. inventory.

Compliance and Environmental Stewardship. EPA continues to improve national environmental performance by ensuring compliance with environmental law and promoting environmental stewardship to conserve resources, prevent pollution, and reduce waste. The Agency uses a wide spectrum of regulatory and nonregulatory strategies, including compliance assistance and incentives, monitoring and data analysis, pollution prevention, and civil and criminal enforcement. EPA also conducts research to identify innovative approaches to environmental protection and encourages states, tribes, and regulated entities to develop new approaches, ideas, and techniques. As an example of success in this area, fiscal year 2004 civil enforcement actions completed, reduced, properly treated, or eliminated an estimated 1 billion pounds of pollutants from release into the environment. An additional 25.3 million pounds of pollutants will be reduced as a result of FY 2004 criminal enforcement actions. Enforcement actions in that year will also require companies to invest $4.8 billion in pollution control and improve environmental management practices at facilities.

These are only a few of the many important environmental successes achieved in the U.S. over the past decades. A more comprehensive look at EPA's programs and progress can be found in the Agency's *Annual Performance Report* series located at: http://www.epa.gov/ocfo/finstatement/apr.htm.

In addition to pollution-associated risk factors that a community may face, there may be other factors affecting overall community health (see box at right). EPA usually has little or no authority to influence many of these factors, but these issues (and others) may nevertheless be identified as important considerations for a community that is seeking to *holistically* enhance its quality of life. Partnership teams working to understand and reduce pollution-associated risk factors will likely become engaged at some level with these other issues. At a minimum, participants in a community-scale environmental assessment project should be sensitive to these other issues and work to help the community identify persons or organizations who can assist them in addressing their other concerns.

Examples of Other Factors That May Affect Community Health

- Crime
- Education
- Diet
- Physical activity level
- Access to health care
- Poverty
- Sexually transmitted diseases
- Substance abuse
- Teen pregnancy
- Jobs

2.3 Localized Assessment and Risk Reduction – A General Goal

EPA is encouraging the use of collaborative community-based approaches to toxics risk reduction in any environmental media by working to develop the tools and support that communities will need to embark upon these projects. This ATRA Library, for example, was developed to fill an important gap in guidance on how to assess and reduce one specific toxics issue – air toxics impacts. Some of the other activities that EPA is pursuing to encourage local scale assessment and risk reduction include:

- Implementation of a National Air Toxics Strategy that, among other things, encourages the use of community-based assessments and risk reduction strategies (discussed above);

- Providing grants and other support to communities performing projects;

- Development of databases of projects to help communities learn from each other (what works well, what does not). For example, EPA recently developed an Air Toxics Community Assessment and Risk Reduction Projects Database to help communities performing air toxics assessments (see Section 2.1);

- Development and implementation of a new program called Community Action for a Renewed Environment, or CARE, an action-oriented effort to reduce the wide variety of toxics risks a community may face (see box on next page); and

- EPA's Community-Based Environmental Protection (CBEP) process, which integrates environmental management with human needs, considers

Who Are the Stakeholders in a Community-scale Project?

The **community** is often thought of as the people who live within the area of impact of pollution sources. In addition to residents, however, other individuals and organizations may also consider themselves "community" stakeholders.

For example, additional stakeholders can include people who own businesses in the area and their employees, local officials, health professionals, and the local media. It is often helpful when performing a community-scale project to keep in mind that many different people and organizations (not just the people who live there) may have an interest in the work being undertaken.

long-term ecosystem health and highlights the positive correlations between economic prosperity and environmental well-being (http://www.epa.gov/ecocommunity/).

Local-scale risk analysis and risk reduction efforts will typically be most successful when government entities and technical experts work effectively with the local community. This is especially true when successful risk reduction relies heavily on the participation of community members. The next section discusses this issue in more detail.

Community Action for a Renewed Environment (CARE)
and the CARE Resource Guide

Community Action for a Renewed Environment (CARE) is a new EPA initiative designed to establish a series of multimedia, community-based and community-driven projects to reduce local exposure to toxic pollution.

Through CARE, EPA is partnering with communities to help them create collaborative partnership teams that may include community organizations, other non-profits, state and local government agencies, other federal agencies, businesses, and academia. These partnership teams will use EPA Cooperative Agreements and other funding to select and implement local voluntary actions that reduce local exposure to toxics. This program will provide technical assistance by helping communities identify and access opportunities through a wide range of voluntary programs. CARE helps communities by responding to their needs, helping to reduce risk, and working with them on solving problems identified within their community. More information about CARE can be found at www.epa.gov/care.

The CARE Resource Guide

The CARE program has developed a Resource Guide to help participating communities, but it can be used by anyone interested in any aspect of working with communities to reduce toxics risks. In the CARE program, communities go through a multi-step process: getting organized, analyzing risks, reducing risks, and tracking progress. The Resource Guide enables partnership teams or anyone working with communities to find the on-line resources that can help their community through every step of the process as they move from getting organized to becoming stewards of their own environment. The first four parts of the Resource Guide track the CARE process and are roughly organized in order of the steps a community would go through as it moves through that process:

Part I	Getting Started and Building Partnerships
Part II	Understanding the Risks in Your Community
Part III	Methods to Reduce Your Exposure
Part IV	Tracking Progress and Moving Forward

Partnership teams are encouraged to use the Resource Guide to help them locate important guidance documents and other information they will need to draw on as they work to perform an analysis of risk factors in their community, select risk reduction projects, and evaluate their efforts over time.

The CARE Resource Guide can be accessed at:
http://cfpub.epa.gov/care/index.cfm?fuseaction=Guide.showIntro

2.4 Community-Scale Stakeholders and the Importance of Community Involvement

As noted previously, EPA and other regulatory programs have been very effective at reducing pollution and improving environmental quality across the United States. However, these programs have not always been able to fully address the varied and multiple impacts from toxic chemicals that people experience in a given place. Instead, community-scale solutions are needed that:

- Focus on a definable geographic area;
- Involve collaboration among a full range of stakeholders through partnerships;
- Assess, protect, and restore the quality of the environment in a place as a whole;
- Integrate public and private action using the most appropriate regulatory and non-regulatory activities to forge effective solutions for each unique community; and
- Monitor and redirect efforts through adaptive management.

Typical stakeholders in this process can include:

- EPA officials;
- State officials;
- Tribal leaders;
- Local officials such as environmental agencies, health department personnel, and city planners;
- Environmental groups;
- Non-governmental organizations (NGOs);
- Environmental justice stakeholders;
- Regulated and non-regulated businesses;
- Community groups;
- Academics; and
- Concerned citizens.

A large, diverse group of stakeholders such as this can provide a wide array of expertise and knowledge to help evaluate an area's interrelated problems. This also encourages the development of effective and appropriate problem-solving tools. For example, an approach that may improve water quality levels but exacerbates other pollution problems would be avoided under this type of community-scale approach because all the right stakeholders are talking to one another. Widespread stakeholder collaboration also improves environmental protection management by providing a means and forum for adaptive problem solving. If a risk reduction method is not working, the relationships established through collaborative work should facilitate discussion and implementation of alternative approaches.

In short, a key ingredient in the success of a toxics assessment and reduction project is effective community involvement since the members of the community are the people who have the greatest vested interest in improving community health. In addition, many laws recognize and accommodate the idea that individuals who are affected by a given decision have the right to participate in the making of that decision (a concept that can benefit non-regulatory activities as well). In the long run, integrating community stakeholders at the outset of the process and making them a trusted and valued partner at all points along the way will help to:

- Produce a comprehensive identification of local environmental toxics concerns;
- Set priorities and goals that reflect overall community values and concerns; and
- Forge comprehensive, short- and long-term solutions that are acceptable to the community and which the community is more likely to take ownership of and sustain over time.

ATRA Volume 1, Chapter 28, provides an overview of this topic. Additional discussions of how to engage the community are provided in Chapters 4 and 10.

Finally, it should be noted that the effort to build stakeholder partnerships and trust, collect and analyze data, write and communicate results, and develop and implement plans for making environmental improvements will likely require significant time and commitment to complete. Depending on the circumstances, it may take anywhere from less than a year to multiple years to develop and implement risk reduction actions. The stakeholder partners will need to adequately plan and make the necessary commitments to be able to complete the process, improve environmental quality, and sustain the effort over time.

Short-Term vs. Long-Term Actions and Results – Differences in Time Scales

The time required to achieve meaningful toxics risk reduction can vary widely depending on the type and scope of the effort that is initiated. Some actions may result in risk reductions in a relatively short time period while other efforts may require more time to bring about results. Two examples are presented here.

- Short-term: Until recently, smoking was allowed in restaurants and other public venues in a community study area. Based on available information on the health impacts of secondhand smoke, the partnership team was able to convince the local government and business community of the immediate need for a ban on smoking in public places. Once the ban went into effect, there was essentially an immediate and dramatic reduction in exposures to secondhand smoke (at least in public places).

- Long-term: In an industrialized urban area with a complex mix of emissions from factories, cars and trucks, and small businesses, a long-term program was established to reduce emissions from all of these types of sources over time. Elements of the plan include:

    - A program to educate residents regarding the benefits of reducing the number of single-passenger cars on the roads during commuting hours by carpooling and ride-sharing;
    - Working with local planning and transportation authorities to site new roadways in such a way as to reduce exposures to residents, increase the availability and attractiveness of mass transit options, institute anti-idling policies, and increase the use of electrified truck stops;
    - Engage industry (both large and small) to identify pollution prevention alternatives that might be instituted ahead of (or in addition to) regulatory requirements. This includes outreach, education, and establishing a local P2 resource center for small business owners.

  Although these actions did not immediately reduce overall air pollutant loadings, the program attempted to target all the important contributors to pollution in the local area, eventually resulting in a cumulative benefit for the community. The benefits of this program would probably take longer to realize than the previous example.

General Resources on Community Involvement

Community-Based Environmental Protection: A Resource Book for Protecting Ecosystems and Communities (http://www.epa.gov/ecocommunity/tools/resourcebook.htm)

The Model Plan for Public Participation (http://www.epa.gov/compliance/resources/publications/ej/)

The RCRA Public Participation Manual (http://www.epa.gov/epaoswer/hazwaste/permit/pubpart/manual.htm)

Enhancing Facility-Community Relations (http://www.epa.gov/epaoswer/hazwaste/tsds/site/f02037.pdf)

Notebook on Local Urban Air Toxics Assessment and Reduction Strategies (http://www.epa.gov/ttn/atw/wks/notebook.html)

References

1. U.S. Environmental Protection Agency. *Agency Mission Statement*. Updated June 11, 2002. Available at: http://www.epa.gov/history/org/origins/mission.htm. (Last accessed March 2004).

2. National Research Council (NRC). 1994. *Science and Judgment in Risk Assessment* (The "Blue Book"). National Academy Press, Washington, D.C.

3. U.S. Environmental Protection Agency. 1999. *National Air Toxics Program: The Integrated Urban Strategy*. *Notice*. *Federal Register* 64:38705. July 19, 1999. Available at: http://www.access.gpo.gov/su_docs/fedreg/a990719c.html (the PDF file is indexed at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1999_register&docid=99-17774-filed.pdf).

4. Institute of Medicine. 1999. *Toward Environmental Justice: Research, Education and Health Policy Needs.* Washington, DC: National Academy Press.